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Analysis of Support Funding for Marine Corps Recruiting

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James H. North

Operations and Support Division

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ABSTRACT

This research memorandum describes a way to account for variation in the average support cost across the Marine Corps recruiting districts. Using FY 1989 and 1990 data, certain variables are found to explain recruiting station support funding costs. Model estimates are made of FY 1992 district support funding requirements. In addition, estimates are made of support cost savings from proposed station consolidations.

EXECUTIVE SUMMARY

The main objective of this research memorandum is to identify an improved method for allocating Marine Corps recruiter support funds to the districts. Concern has been expressed that the current system for allocating support funds does not adequately address the regional differences in support funding requirements. The method developed here focuses on providing a framework for allocating support funds in a manner that compensates for these differences.

Marine Corps Headquarters allocates $41 million of the $45-million budget to recruiting districts based almost exclusively on the proportion of national accessions allocated to that district. Table I compares district shares of support funding and recruiting accessions for FY 1990. The largest differences between mission shares and support funding shares are 0.3 percentage points in the 4th and 6th districts.

Table I. FY 1990 allocation of support funding and percentage of accession quota

	Percentage	
District	Support funding	Accessions
1st	13.0	12.9
4th	17.0	17.3
6th	16.0	15.7
8th	17.8	18.0
9th	17.3	17.4
12th	18.9	18.7

Unlike headquarters, districts allocate funds to stations and recruiters based on the perceived costs of recruiting at the station and recruiter levels. District personnel have better information than headquarters on local recruiting costs, and funds are distributed based on this information. Discussions with headquarters and district fiscal officers indicated that the objective of the district personnel is to create equal recruiting opportunities for each station and the recruiters assigned to it. Thus, if there are differences in the average cost of recruiting between different stations in a district, district personnel will account for this in the way they allocate funds to the stations.

It is assumed that the districts' current weighting of factors that affect their distribution of funds to stations is a system that headquarters might use to allocate support funds to districts. To quantify the influence of various factors on the allocation of support funds to stations, regression estimates were made of costs using data from FY 1989 and FY 1990. The dependent variable is total station and recruiter costs. The explanatory variables are the station's square mileage relative to the production-weighted qualified military available (which is used to represent an area's potential recruit market), the size of the recruiting mission, the number of substations in the station, and whether the observation is for FY 1990.

These estimates were aggregated to identify a potential allocation of funds to the districts for FY 1992. The results of this allocation are shown in table II. Columns 2 through 5 show breakdowns of the support budget into four categories. The station and recruiter budget and the reserve budget reflect an allocation of funds based on the model's estimates. Column 7 shows the proportion of the support funding budget that would be allocated to each district, and column 8 shows the recruiting mission proportions. The projections indicate increases in funding for the 1st and 8th districts relative to an allocation scheme based on mission shares. The 4th and 6th districts would experience decreases, and the 9th and 12th districts would receive roughly the same funding under either allocation scheme.

Table II. FY 1992 estimated support funding and recruiting mission share

	Support budget (FY 1990 dollars)						
District	Station and recruiter	Reserve	OSO	District office	Total	Estimated budget share	FY 1992 mission share
1st	3,508,015	231,549	345,799	1,130,329	5,215,692	12.7	12.0
4th	4,994,462	329,663	425,850	1,130,329	6,880,304	16.7	17.3
6th	4,607,985	304,154	470,344	1,130,329	6,512,812	15.9	16.7
8th	5,945,788	392,457	537,579	1,130,329	8,006,153	19.5	18.8
9th	5,143,106	339,475	490,299	1,130,329	7,103,209	17.3	17.3
12th	5,529,582	364,985	342,563	1,130,329	7,367,459	17.9	17.9
Total	29,728,938	1,962,283	2,612,434	6,781,974	41,085,629	100.0	100.0

A secondary objective of the research memorandum is to estimate support funding savings from station consolidations. This analysis focuses on support

funding savings alone. When considering these consolidations, total cost savings from a proposed consolidation should be the primary focus, and support funding is only one part of total cost. The estimates suggest that for each station consolidation, support funding requirements would be reduced by about $100,000.

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INTRODUCTION

With the reduction in Marine Corps strength comes an anticipated reduction in the recruiting mission over the next few years. The reduced mission will create pressure to make cuts in the recruiting budget. Recruiting expenses, therefore, must be allocated in the most efficient manner.

Support costs are a part of total recruiting costs. Concern has been expressed that the current system for allocating support funds does not adequately address the regional differences in support funding requirements. The present approach has been to allocate support funds to the recruiting districts in rough proportion to their recruiting mission. Such an approach implicitly assumes uniform average recruiting costs across all the districts.

The Marine Corps recruiting service is a national operation and currently wants all regions of the country to have recruiters available to enlist young men and women. It has been argued that rural regions are likely to have higher support costs than urban regions because recruiters must drive many more miles and make more long-distance phone calls. Assuming uniform average recruiting costs, however, puts districts that contain more rural areas at a disadvantage.

The primary objective of this research memorandum is to identify an improved means for allocating support funds. The method developed here focuses on compensating for regional differences in average support funding requirements by modeling the way recruiting districts allocate station and recruiter funds to stations. It is assumed that the districts' current weighting of factors affecting their distribution of funds to stations is a system that headquarters might use to allocate support funds to districts. Projections are made of FY 1992 station-level support funding requirements, which are then aggregated to the district level. Estimates of the effect of proposed recruiting station consolidations on support funding requirements are also presented.

Support Funding and Total Cost of Recruiting

The total cost of recruiting includes the cost of facilities, salaries and benefits of military personnel involved in recruiting, and recruiting support. Facility costs include the lease and maintenance of recruiting office space, and these expenses are included in the Army Corps of Engineers recruiting facility budget. The Marine Corps is allocated a share of this budget. Salaries and benefits of military personnel are included in the Marine Corps military compensation budget, which is centrally

managed. However, the Marine Corps recruiting service manages an annual budget of $45 million, which goes toward covering recruiter support costs. These support costs are a large part of total recruiting costs. If support costs, rent on facilities, and military salaries are included, the total cost of recruiting in FY 1990 was about $202 million. Thus, support costs represent between 20 and 25 percent of the total cost.

The recruiter support funding pays for recruiter communication and transportation. It also is used for advertising, civilian personnel compensation, and other general expenses related to the operation of the recruiting service. A final major category of expenses included in the support funding budget is applicant travel and lodging.

Marine Corps Recruiting Structure

Table 1 outlines the structure, as of FY 1991, of the Marine Corps recruiting service. Two regions (Eastern and Western) direct the activities of three recruiting districts each. The districts comprise 50 recruiting stations. Individual recruiters report to the recruiting station commanding officers. Figure 1 identifies the six districts and shows the boundaries of the 50 recruiting stations.

Table 2 shows the allocation of support funds in the FY 1990 budget. Of a budget totaling about $45 million, $41 million was allocated to the recruiting districts. The remaining $4 million was used by Marine Corps Headquarters to support the districts or was used in the Marine Corps' national advertising campaign. The districts allocated the $41 million to expenses for district offices, recruiting stations, Officer Selection Offices (OSOs), and recruiters. Recruiter support costs are further subdivided into regular and reserve recruiting.

Headquarters allocates the $41 million to districts based almost exclusively on the proportion of national accessions allocated to that district. Table 3 provides a comparison of district shares of support funding and recruiting accessions for FY 1990. The largest differences between mission shares and support funding shares are 0.3 percentage points in the 4th and 6th districts.

Unlike headquarters, districts allocate funds to stations and recruiters based on the perceived costs of recruiting at the station and recruiter levels. District personnel have better information than headquarters personnel on local recruiting costs, and funds are distributed based on this information. Discussions with headquarters and district fiscal officers indicated that the objective of the district personnel is to

create equal recruiting opportunities for each station and the recruiters assigned to it. If there are differences in the average cost of recruiting between different stations in a district, district personnel will account for this in the way they allocate funds to the stations.

Table 1. Recruiting structure

Eastern Region district	Station	Western Region district	Station
1st	Albany	8th	Albuquerque
	Boston		Dallas
	Buffalo		Denver
	Hartford		Houston
	N. New England		Kansas City
	N. New Jersey		Little Rock
	New York		New Orleans
			Oklahoma City
4th	Baltimore		Omaha
	Charleston		San Antonio
	Cincinnati		
	Cleveland	9th	Chicago
	Harrisburg		Detroit
	Louisville		Indianapolis
	Philadelphia		Lansing
	Pittsburgh		Milwaukee
	Richmond		Rock Island
			St. Louis
6th	Fort Lauderdale		Twin Cities
	Jacksonville		
	Macon	12th	Los Angeles
	Montgomery		Orange
	Nashville		Phoenix
	Orlando		Portland
	Raleigh		Sacramento
			Salt Lake City
			San Diego
			San Francisco
			Seattle

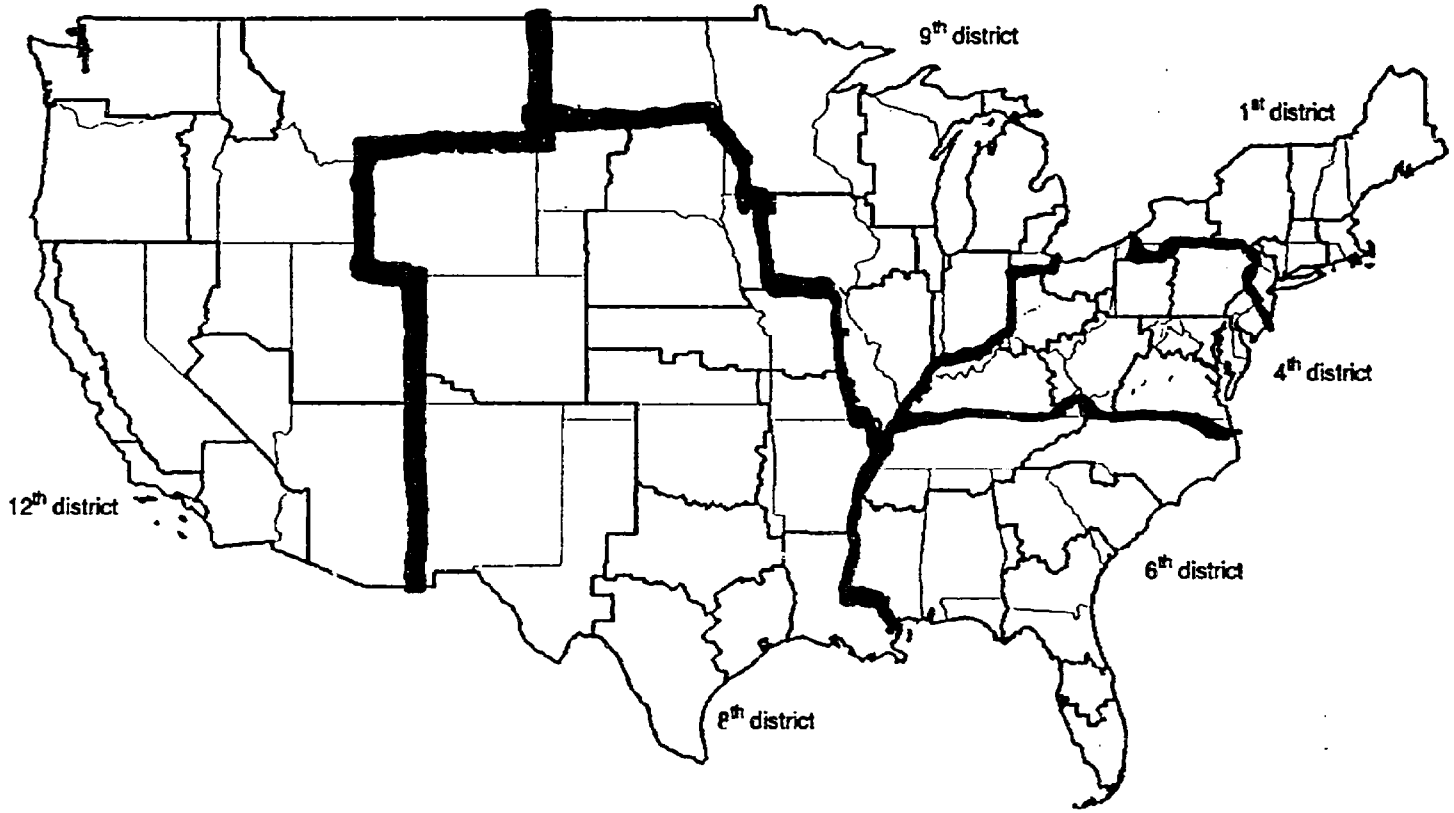

Figure 1. Marine Corps recruiting districts

Table 2. FY 1990 support funding allocation

Funding category	Funding (millions of dollars)
Headquarters	4
District offices	6.8
Station and recruiter (regular)	29.7
Recruiter (reserve)	1.9
Officer Selection Office (OSO)	2.7
Total	45.1

Table 3. FY 1990 allocation of support funding and percentage of accession quota

	Percentage	
District	Support funding	Accessions
1st	13.0	12.9
4th	17.0	17.3
6th	16.0	15.7
8th	17.8	18.0
9th	17.3	17.4
12th	18.9	18.7

The focus of this research memorandum is to measure the importance of factors that determine districts' allocations of support funds to the stations. It is assumed that the districts' current weighting of factors that affect their distribution of funds to stations is a system that headquarters might use to allocate support funds to districts. As an example, if it is found that, on average, districts allocate 1 percent more support funds for each 2 percent increase in a stations' net contracts while all other factors remain the same, perhaps headquarters should consider doing this in allocating support funds to districts.

REASONS FOR VARIATIONS IN RECRUITING COSTS

The existing system of allocating support funding to the districts from headquarters implicitly assumes identical average costs of procuring new recruits for each district.[1] For certain costs, this assumption may be valid. Many items

1. Average cost refers to the total cost divided by net new contracts or accessions or the cost per net contract or accession.

purchased by districts, such as furniture and office supplies, are bought at national prices from the General Services Administration (GSA). Also, vehicle leases with GSA, not including mileage, are the same nationally.[1] For certain other costs, the assumption of identical average costs of procuring new recruits for each district may not be valid. How these costs vary can be seen in the station-level data.

Station-level average costs may differ for several reasons. These reasons include geographical area relative to the potential market size, the amount of structure within the station (as indicated by the number of substations), and the size of the station's recruiting mission.

Geographical Area

First, the geographical area covered by stations varies greatly. This, in itself, would not cause major differences in average costs if potential recruits were evenly spread across the nation. In other words, if the 1st district had 12 percent of the total U.S. square mileage and 12 percent of the potential recruits, the area covered to contact potential recruits would not necessarily be any different from the national average. On the other hand, if the 1st district had 12 percent of the square mileage with 6 percent of the potential recruit market, its average costs could be expected to be higher.

Two support expenses that are heavily influenced by size of the area covered relative to potential recruits are transportation and communication. Recruiters covering large areas with more dispersed potential recruits must drive more miles and make more long-distance phone calls than those with relatively smaller areas and more concentrated potential recruits. For transportation, districts must pay for mileage driven, in addition to the fixed lease districts pay for using the vehicles. Because transportation and communication account for 32.3 and 24.1 percent of total support expenses, respectively, large variation in average recruiting costs could result.

An additional expense that is expected to vary with the size of the area covered is boarding and lodging of applicants. Applicants traveling large distances to visit the military entrance processing stations (MEPSs) must spend a night in a hotel while those close to the stations will have an opportunity to go home. In FY 1990, 6.4 percent of support costs included applicant boarding and lodging.

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1. Different parts of the country may have to lease different types of vehicles, and leases vary with the type of vehicle; the Western Region's districts may require more four-wheel drive vehicles relative to Eastern Region's districts.

There is considerable variation in the area to be covered relative to the production-weighted qualified military available (PQMA), which is used to represent an area's potential recruit market.[1] Table 4 provides data on the square mileage divided by PQMA within each recruiting station and district using FY 1990 data.[2] Only two stations in the 1st, 4th, and 6th districts (Eastern Region) had more than 1 square mile per PQMA, whereas 15 of 26 stations in the Western Region have more than 1 square mile per PQMA. One would expect this factor to raise the average cost of recruiting in the more sparsely populated and geographically larger stations in the Western Region.

Table 5 shows the FY 1990 average support cost per contract for the recruiting stations in the 1st district. Also shown is the recruiting station's square miles per contract. Note that the Northern New England and Albany stations have the highest average cost and also the largest number of square miles per contract. The Boston station has the lowest average cost and the second lowest square mileage per contract. Thus, there seems to be a positive relationship between the average recruiting cost and the geographical area to be covered to get to potential recruits, at least in the 1st district. This relationship will be modeled for stations from all the districts.

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1. $PQMA_i$ is derived as follows:

$$PQMA_i = QMA_{nat} * Enl_i/Enl_{nat} \ ,$$

where QMA_{nat} is an estimate of the national qualified military availables or 17- to 21-year-old males who are high school diploma graduates (HSDGs) and would score in AFQT categories I-IIIa. Enl_i and Enl_{nat} are the number of local and national DOD enlistments who are HSDG males and scored in AFQT categories I-IIIa. Thus, $PQMA_i$ is an estimate of local production-weighted qualified military availables. It is a fair representation of the potential recruit market in an area. PQMA estimates have become the basis for the Marine Corp's allocation of accession quota to the districts and are discussed in [1].

2. Fort Lauderdale and Salt Lake City are not included in table 4 because they only recently became fully functional (in FY 1991).

Table 4. FY 1990 district and station square miles per PQMA

District	Station	FY 1990 square miles per PQMA
1st	Albany	0.80
	Boston	0.14
	Buffalo	0.38
	Hartford	0.28
	N. New England	1.21
	N. New Jersey	0.16
	New York	0.03
	Average	0.43
4th	Baltimore	0.27
	Charleston	0.96
	Cincinnati	0.35
	Cleveland	0.22
	Harrisburg	0.52
	Louisville	0.90
	Philadelphia	0.15
	Pittsburgh	0.35
	Richmond	0.59
	Average	0.48
6th	Jacksonville	0.89
	Macon	0.59
	Montgomery	1.11
	Nashville	0.90
	Orlando	0.28
	Raleigh	0.77
	Average	0.76
8th	Albuquerque	4.27
	Dallas	0.85
	Denver	3.86
	Houston	0.49
	Kansas City	1.93
	Little Rock	1.53
	New Orleans	0.78
	Oklahoma City	1.90
	Omaha	3.63
	San Antonio	1.18
	Average	2.04

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Table 4. (*Continued*)

District	Station	FY 1990 square miles per PQMA
9th	Chicago	0.09
	Detroit	0.17
	Indianapolis	0.59
	Lansing	0.53
	Milwaukee	1.14
	Rock Island	1.15
	St. Louis	0.80
	Twin Cities	2.57
	Average	0.88
12th	Los Angeles	0.20
	Orange	0.33
	Phoenix	4.50
	Portland	3.13
	Sacramento	2.11
	San Diego	1.05
	San Francisco	0.71
	Seattle	12.08
	Average	3.01

Table 5. 1st district stations' support cost per net contract and square mileage per net contract for FY 1990

Station	Support cost per net contract (FY 1990 dollars)	Square miles per net contract
Albany	783	44
Boston	456	6
Buffalo	512	20
Hartford	529	13
New York	505	1
Northern New England	700	71
Northern New Jersey	470	7

Number of Substations

Another reason station-level average costs may differ is because the underlying structure of each station differs considerably. The number of recruiting offices can be an important determinant of average cost at the station level.[1] Table 6 shows the number of recruiting substations in each recruiting station during FY 1990.[2] It is not as clear that additional substations will increase support costs. Maintaining a substation requires minimal expenses. These expenses include furniture maintenance and phone connections. Other minor expenses may be added for periodic transportation to and from the station headquarters. However, transportation and communication expenses are reduced because additional substations put recruiters closer to potential recruits. These latter cost reductions may exceed the former cost increases.

Nonetheless, reductions in potential support costs from more substations may be offset by reduced station oversight of recruiter operations. With more substations, it becomes more difficult for station personnel to follow the activities of recruiters.

If facility expenses were considered, it would be less likely that more substations would reduce expenses. However, the additional substations can increase the recruiters' effectiveness by bringing them closer to the market and reducing their driving time.

No close relationship exists between mission and the number of substations in a station. Substations have not opened or closed in proportion to changes in a district's share of recruiting mission. As an example, San Diego had 6 substations in FY 1990 and Seattle had 15. This ratio is not close to corresponding to the production of 2.0 and 2.6 percent of total FY 1990 Marine Corps net contracts procured in San Diego and Seattle, respectively. There may be reasons specific to an area that justify different numbers of substations. For example, the area covered by the San Diego station may have most of its population concentrated in the San Diego area, which means that larger office sizes can be used without adding large amounts in driving and long-distance phone expenses.

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1. At a district level, there is sure to be some variation in the average cost of recruiting, depending on the number of stations it has.
2. Substations tend to be manned by two, three, or four recruiters with a noncommissioned officer-in-charge present who can be actively recruiting or may be performing other duties. Smaller offices, which are not included in the table, are permanent contact stations and temporary recruiting facilities. There were approximately 1,050 of these smaller offices across the nation in FY 1990.

Table 6. Number of substations in each station during FY 1990

District	Station	Number of substations
1st	Albany	7
	Boston	12
	Buffalo	10
	Hartford	8
	N. New England	11
	N. New Jersey	19
	New York	15
4th	Baltimore	15
	Charleston	7
	Cincinnati	10
	Cleveland	9
	Harrisburg	11
	Louisville	8
	Philadelphia	9
	Pittsburgh	13
	Richmond	12
6th	Jacksonville	10
	Macon	13
	Montgomery	11
	Nashville	8
	Orlando	14
	Raleigh	10
8th	Albuquerque	10
	Dallas	12
	Denver	13
	Houston	11
	Kansas City	10
	Little Rock	8
	New Orleans	12
	Oklahoma City	10
	Omaha	9
	San Antonio	10
9th	Chicago	20
	Detroit	15
	Indianapolis	16
	Lansing	15
	Milwaukee	20
	Rock Island	13
	St. Louis	13
	Twin Cities	22
12th	Los Angeles	13
	Orange	10
	Phoenix	12
	Portland	12
	Sacramento	10
	San Diego	6
	San Francisco	13
	Seattle	15

Size of Recruiting Mission

Another cause for variation in support funding requirements is a station's recruiting mission size. Recruiting stations with less than the average recruiting missions are likely to have higher than average support expenses. All recruiting station offices are likely to have roughly the same amount of office furniture, civilian personnel, telephone connections, and other general office expenses. Although increasing the recruiting mission is likely to increase recruiter expenses in terms of long-distance calls and transportation expenses, it is not likely to increase station office expenses substantially. Thus, average costs are likely to go down with increasing size of mission because there is less overhead per recruit in the station with the larger mission.[1]

The proportion of national mission varies widely among stations. Table 7 shows the proportion of net contracts signed by each recruiting station during FY 1990. It also shows the proportion of the FY 1992 national PQMA for each station.

Whether looking at past production, as indicated by FY 1990 production, or the size of the potential market, as indicated by PQMA, wide variations in size or potential size are evident. Within each district, the smallest station is about half the size of the biggest station. Nationally, in terms of PQMA, Recruiting Station (RS) Orange, the smallest station, is about one-quarter the size of RS Macon, the largest station. These differences suggest large differences in recruiting overhead relative to recruit contract production.[2]

METHODOLOGY AND DATA

Districts receive support funding from Marine Corps Headquarters based on their share of the national recruiting goal; the allocation of funds to the stations and recruiters is less straightforward. District personnel have better information than Marine Corps headquarters does on their station and recruiter costs, and the assumption is that funds are allocated to the stations and recruiters on the basis of this added information.

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1. Allowing stations to get too large, however, is not advisable. Station military and civilian personnel add quality control to the recruiting process and provide significant assistance to recruiters. As stations become too large, the amount of this assistance diminishes.
2. Overhead refers to the support funding used for station offices, station lease space, and military personnel who are not recruiters.

Table 7. Proportions of FY 1990 net contract product and FY 1992 production-weighted qualified military available (PQMAs)

District	Station	FY 1990 production	FY 1992 PQMA
1st	Albany	1.32	1.45
	Boston	1.95	1.59
	Buffalo	1.44	1.45
	Hartford	1.50	1.41
	N. New England	1.41	1.55
	N. New Jersey	1.73	1.41
	New York	2.74	2.04
	Total	12.09	10.90
4th	Baltimore	2.91	2.38
	Charleston	1.23	1.31
	Cincinnati	2.03	2.42
	Cleveland	2.20	2.45
	Harrisburg	1.64	1.63
	Louisville	1.31	1.72
	Philadelphia	1.87	1.50
	Pittsburgh	1.45	1.76
	Richmond	1.99	1.87
	Total	16.63	17.04
6th	Fort Lauderdale[a]	0.99	1.92
	Jacksonville	2.12	1.88
	Macon	3.35	3.26
	Montgomery	2.54	3.10
	Nashville	2.45	2.69
	Orlando	2.79	2.20
	Raleigh	2.41	2.83
	Total	16.65	17.88
8th	Albuquerque	1.53	1.95
	Dallas	2.88	2.96
	Denver	1.98	2.29
	Houston	2.25	2.27
	Kansas City	1.39	1.44
	Little Rock	1.58	1.95
	New Orleans	2.36	2.14
	Oklahoma City	1.64	1.92
	Omaha	1.23	1.32
	San Antonio	2.48	2.44
	Total	19.32	20.68

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Table 7. (*Continued*)

District	Station	FY 1990 production	FY 1992 PQMA
9th	Chicago	3.22	2.41
	Detroit	2.38	2.37
	Indianapolis	1.92	2.08
	Lansing	2.55	2.35
	Milwaukee	1.76	1.65
	Rock Island	1.38	1.46
	St. Louis	2.18	2.49
	Twin Cities	1.94	2.30
	Total	17.33	17.12
12th	Los Angeles	2.33	2.24
	Orange	1.59	0.77
	Phoenix	2.81	2.10
	Portland	1.93	1.78
	Sacramento	2.25	2.13
	Salt Lake City[a]		1.53
	San Diego	1.97	1.80
	San Francisco	2.44	1.61
	Seattle	2.65	2.43
	Total	17.97	16.40

a. RS Fort Lauderdale and RS Salt Lake City became fully operational in FY 1991.

Discussions with headquarters and district fiscal officers revealed that support funds are distributed by district personnel in a manner that equalizes the constraints put on stations and recruiters. The reasons why some stations and recruiters get more funds than others can be explained in part by the factors discussed earlier. Hence, it can be expected that the districts allocate more funds to stations and recruiters with more geographical area to cover relative to the PQMA. They also allocate more funds to stations with a larger mission and may provide different levels of funding to stations depending on the number of substations within the station.

Regression Model

To capture the statistical relationship between the station and recruiter-level costs and the variables that seem to explain its variation, regression analysis was used. This cost relationship, for any given fiscal year, can be described as follows:

$$C_{it} = a + \sum_{j=i}^{M} B_j X_{jit} + u_{it} \quad ,$$

where

C = support funding level for specific stations and their recruiters

X = explanatory variables for funding level (number of net contracts, number of substations, and square mileage per PQMA)

u = a random error term that represents the unsystematic effects of all factors other than those included in X

a, B = unknown parameters to be estimated by statistical inference

j = an index of the explanatory variables (i = 1,2, ..., M)

i = an index of the stations (i = 1,2 ..., N)

t = an index of fiscal years (t = 1,2 ..., T).

Appendix A shows the development of the equation used in the statistical analysis. It also discusses how two years of data are pooled together, the functional form used, and statistical measures that can be tabulated from the results.

The primary statistical objective is to obtain estimates of the model's parameters and to test hypotheses regarding the parameters and the overall relationship. The dimensions of the relationship between the explanatory variables of support funding and station and recruiter support funding levels will be derived.

Once reasonable estimates are derived, projections will be made of the FY 1992 station and recruiter-level funding based on model results. These station and recruiter funding predictions will be aggregated to the district level and a model-derived

fair share estimate will be made for each district's FY 1992 funding level. In addition, model projections will be made of what support funding savings might be achieved from various proposals for station consolidation.

Data

To develop a measure of station and recruiter costs (i.e., the dependent variable), FY 1989 and FY 1990 district accounting data were collected. To the extent possible, expenditures were allocated to the stations where they were incurred. Recruiter expenditures were allocated to the station where each recruiter was assigned. Only regular recruiting expenditures were included in the station cost variable because a breakdown by station of reserve recruiting expenditures could not be obtained from some districts. The only district expenditures to be excluded from station costs were district office expenses, reserve recruiting expenses, and Officer Selection Office (OSO) expenses. The included station and recruiter costs account for 75 percent of the $41 million allocated to districts during FY 1990.

During FY 1989 and FY 1990, 48 stations were fully operational. Cost data were included for all stations and both years, for a total of 96 observations. Initial expenditures were made in RS Fort Lauderdale, which became fully operational in FY 1991, but these expenditures were included in RS Orlando's cost. RS Salt Lake City did not yet appear in the FY 1990 data.

The first explanatory variable developed was the net contracts by station for FY 1989 and FY 1990. This variable consisted of all new contracts in a station minus any delayed entry program (DEP) discharges. Reserve and regular net contracts were included in the calculation.[1] The 1st district's contract production in Europe was not included in the calculation of net contracts.

A station's square mileage divided by its production-weighted qualified military available (PQMA) was developed as a measure of a station's geographical area to be

1. Reserve contracts were included because reserve recruiting is a large share of total contract production by the Marine Corps recruiting service. During FY 1990, almost 20 percent of all net contracts were reserve contracts. However, reserve recruiting support funds allocated to the districts totaled less than $2 million, or about 5 percent of station funds. Headquarters fiscal personnel felt that this did not come close to covering the true cost of reserve recruiting. Reserve costs were not included in the cost variable because a breakdown of costs by station could not be obtained from certain districts. It is not believed that this gap would seriously affect the estimates because one would expect station reserve recruiting costs to be affected by the explanatory variables in the same manner as regular recruiting costs.

covered to reach the potential market. Station square mileage estimates were derived by tabulating the square mileage of all counties within a station. PQMA is an indicator of potential market size used by the Marine Corps in determining the districts' allocation of recruiting mission.[1] To obtain the PQMA in a station, one tabulates the most recent records on DOD-wide net contract production of high school diploma graduate (HSDG) males coming from each station who scored in the Armed Forces Qualification Test (AFQT) categories I through IIIa. A station's proportion of national production is calculated and multiplied by a national estimate of 17- to 21-year-old HSDG males who would be predicted to score in AFQT categories I through IIIa had they taken the examination. For FY 1989 observations, FY 1989 DOD net contracts were used, and FY 1990 net contracts were used for FY 1990 observations.

The number of substations in a station is the final explanatory variable. Stations have provided these numbers to Marine Corps headquarters for FY 1989 and FY 1990.

Table 8 provides descriptive statistics for each of the variables. Table 9 shows the descriptive statistics for each of the years. Square miles per PQMA has a very wide range, with the largest value being about 400 times the size of the smallest. RS New York has the smallest value with approximately 1 square mile for each 35 PQMA. At the other extreme is RS Seattle, which in FY 1989 and FY 1990 included Alaska, Washington State, the northern part of Idaho, and Montana. It had approximately 10.11 square miles per PQMA in FY 1989 and 10.78 square miles per PQMA in FY 1990.

Table 8. Descriptive statistics for FY 1989 and 1990 combined—96 observations

	Variable			
Statistic	Station costs (dollars)	Square miles per PQMA	Number of net contracts	Number of substations
Mean	634,133	1.25	950.8	11.7
Standard deviation	146,393	1.69	285.3	3.5
Minimum value	339,009	0.03	475	6
Maximum value	1,035,345	10.78	1,902	26

1. See [1] for a discussion of the development of PQMA.

Table 9. Descriptive statistics by fiscal year—48 observations

Statistic	Variable			
	Station costs (dollars)	Square miles per PQMA	Number of net contracts	Number of substations
FY 1989				
Mean	628,676	1.25	853.2	11.9
Standard deviation	145,638	1.65	239.9	3.6
Minimum value	339,009	0.03	475	7
Maximum value	954,976	10.11	1,526	26
FY 1990				
Mean	639,589	1.26	1,048.4	11.5
Standard deviation	148,481	1.74	295.9	3.3
Minimum value	385,803	0.03	594	6
Maximum value	1,035,345	10.78	1,902	22

An additional variable is included that indicates whether the observation was for FY 1990. See appendix A for further discussion of this variable.

ESTIMATION RESULTS

Appendix B contains the specific estimation results. A discussion of the qualitative results will be followed by a presentation of the quantitative implications of the model estimation results.

Qualitative Results

All explanatory variables included in the model influence the station support costs. An increase in the number of net contracts will lead to higher station support costs, as expected. An increase in the square mileage per PQMA will also result in increased station support costs. Both these results were anticipated. An increase in

the number of substations will also lead to higher support costs. During FY 1990, stations were found to have lower support costs when all other variables were held constant.[1] This decrease may be an indication of recruiting efficiency gains in the latter year. Total Marine Corps net contracts increased from 40,963 in FY 1989 to 50,371 in FY 1990 without a substantial increase in support funding. However, it could also be an indication that investments were put off in that year so that funds could be spent on the immediate recruiting needs.

The model estimates explain approximately 75 percent of the variation in the station support costs, indicating that even the limited number of variables included in the model explains cost variations reasonably well.

Quantitative Results

This subsection examines the predicted effect of changes in the explanatory variables on support funding. The model predicts that a 30-percent increase in net contracts from the mean value results in an increase in support costs of 21 percent, or $131,000, over the sample mean.[2] This change is made holding all other variables at their sample mean. Based on this prediction, as a station's net contracts increase, the station support costs do not rise proportionately; thus, the average cost per contract goes down. In other words, there are economies of scale with respect to station and recruiter support costs. This is likely to be largely explained by the relatively fixed station office overhead costs during the period included in the estimation. Station offices have an almost uniform number of military and civilian billets, regardless of mission size. If the phone and office equipment are also about equivalent, it is clear that, compared with large stations, those with smaller missions must cover more overhead per contract.

If the square mileage per PQMA is increased by 140 percent over the mean value, the model predicts an 8-percent increase in support costs. Relative to the mean level of support costs, this reflects a $58,000 increase in station support

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1. Obviously, support costs were higher in FY 1990 than FY 1989. However, after adjusting for the number of contracts, substations, and square miles per PQMA during FY 1990, the support costs (per the level of these variables) actually decreased. As an example, net new contracts increased by 25 percent. The support costs per contract decreased.
2. As can be seen in table 8, there is large variation in the square mileage per PQMA variable, but the number of net contracts and number of substations vary within a comparatively narrow range. Thus, the effect on support funding of an increase in the explanatory variable equal to its sample standard deviation is used. See appendix C for an explanation of standard deviation.

funding. This increase in station support costs likely results from the added miles driven by recruiters and increased number of long-distance phone calls made in stations with more miles to cover to reach potential recruits.

When the number of substations is increased by 30 percent from the sample mean and all other variables are at their average value, the model predicts a 3-percent increase in support costs, or $18,000.

FY 1992 SUPPORT FUNDING PROJECTIONS

Station and Recruiter Support Funding Projections

Using model estimates and making certain assumptions about the data, it is possible to project how support funds ought to be allocated to the districts for FY 1992. Data modifications are necessary to reflect the FY 1992 conditions more accurately. In FY 1991, RS Lauderdale and RS Salt Lake became fully operational. Adjustments to the stations from which RS Lauderdale and RS Salt Lake were formed are necessary, along with adding data on these two stations.

At this time, the Marine Corps is projecting that net contracts will total 36,920 for FY 1992. These contracts must be allocated among the stations. The national recruiting mission is allocated to the districts, but the districts have discretion over how the mission is divided among its stations. Districts' proportions of the national mission are gradually being brought into line with their proportion of PQMA. However, because PQMA was first used as an analytic tool for allocating mission in FY 1991 and the Marine Corps recruiting service wants to make a gradual adjustment to the proportions suggested by PQMA, FY 1992 district recruiting mission proportions deviate from PQMA proportions.

In dividing the FY 1992 mission among their stations, districts probably will not deviate far from stations' proportion of a district's FY 1992 PQMA. Thus, a station's proportion of district PQMA is multiplied by the district's FY 1992 mission to obtain an estimate of the station's net contract production for FY 1992. As an example, because RS Albany has 13.3 percent of the 1st district's PQMA, RS Albany is assumed to procure 13.3 percent of the 1st district's recruiting mission.

The number of substations and the geographical size per PQMA are not expected to change for FY 1992.

Based on these assumptions and data modifications, estimates are made of the proportion of all FY 1992 station and recruiter-level support funding levels by using the estimated model as a predictive equation. These predicted proportions are shown in column 3 of table 10. Column 4 shows each station's estimated proportion of the FY 1992 national mission.

Table 10. FY 1992 predicted share of station and recruiter support costs and estimated recruiting mission shares

District	Station	Share of funds allocated using model	Recruiting mission shares[a]
1st	Albany	.017	.016
	Boston	.017	.018
	Buffalo	.016	.016
	Hartford	.015	.015
	N. New England	.019	.017
	N. New Jersey	.015	.015
	New York	.019	.023
	Total	.118	.120
4th	Baltimore	.022	.024
	Charleston	.015	.013
	Cincinnati	.022	.025
	Cleveland	.021	.025
	Harrisburg	.018	.017
	Louisville	.018	.017
	Philadelphia	.015	.015
	Pittsburgh	.018	.018
	Richmond	.019	.019
	Total	.168	.173
6th	Jacksonville	.019	.018
	Macon	.027	.030
	Montgomery	.027	.029
	Nashville	.023	.025
	Orlando	.018	.020
	Raleigh	.024	.026
	Fort Lauderdale	.017	.018
	Total	.155	.167
8th	Albuquerque	.021	.018
	Dallas	.025	.027

(continued on next page)

Table 10. (*Continued*)

District	Station	Share of funds allocated using model	Recruiting mission shares[a]
	Denver	.023	.021
	Houston	.020	.021
	Kansas City	.016	.013
	Little Rock	.019	.018
	New Orleans	.020	.019
	Oklahoma City	.019	.017
	Omaha	.015	.012
	San Antonio	.022	.022
	Total	.200	.188
9th	Chicago	.021	.024
	Detroit	.022	.024
	Indianapolis	.021	.021
	Lansing	.023	.024
	Milwaukee	.020	.017
	Rock Island	.017	.015
	St. Louis	.024	.025
	Twin Cities	.025	.023
	Total	.173	.173
12th	Los Angeles	.022	.024
	Orange	.010	.008
	Phoenix	.024	.023
	Portland	.021	.020
	Salt Lake City	.020	.017
	Sacramento	.023	.023
	San Diego	.019	.020
	San Francisco	.019	.018
	Seattle	.028	.026
	Total	.186	.179

a. Shares are allocated by assuming that the district allocates its FY 1992 mission to the stations in proportion to their share of the district's FY 1992 PQMA.

Other Funding Projections

Station and recruiting support funds account for only 75 percent of the $41 million allocated to the districts; the remaining $10 million must be allocated. Of this, $1.9 million was allocated to reserve recruiting. Because reserve recruiting

was included in the net contract numbers used in the model estimation and the potential market for reserves is assumed to be identical to that for regulars, the effects of the number of substations and geographical area per PQMA are expected to be the same for reserve recruiting as for regular recruiting. These funds are allocated to the districts in the same proportions as the regular station and recruiter support funds. (These proportions were shown in table 10.)

In FY 1990, $2.7 million was allocated to OSOs. Although no analysis has been done of OSO funding requirements, it has been assumed that, regardless of changes in mission requirements, station-level OSO requirements should remain fairly stable. In other words, most OSO expenses go into OSO office expenses. Thus, it is assumed that OSO expenses can be allocated in the same manner as they were during FY 1990.

Finally, district office support funding requirements must be considered. The Marine Corps removed bachelor leased housing and facility maintenance expenses from the support funding budget in FY 1991, and table 11 shows the FY 1990 district office support funding levels without these expenses. The variation in these levels may reflect districts compensating past high or low investment levels. Such variation would not be expected to persist over time. Because all districts have the same amount of civilian and military billets, they are likely to have very similar office equipment requirements. District office funding for FY 1992, therefore, was predicted by taking the total district office funding for FY 1990 and dividing it six ways equally.

Table 11. FY 1990 district office support funding

District	Funding (FY 1990 dollars)
1s	1,090,656
4th	1,058,071
6th	696,532
8th	663,608
9th	1,141,035
12th	1,270,324
Total	5,920,226

NOTE: Amounts exclude bachelor leased housing and facility maintenance expenses, which are no longer part of the support funding budget.

The results of these allocations are shown in table 12. The total dollar amounts under each major budget category are equal to the FY 1990 totals; division among the districts has been made based on the foregoing estimates and assumptions. The second and third columns show the station and recruiter budget and the reserve budget, which are allocated using the proportions predicted by the model. Column 4 shows the OSO budget allocation (based on the historical allocation), and column 5 shows the district office budget, which is evenly allocated. Column 6 totals the support budget, and the next column shows the district's proportion of that total. The last column shows the recruiting mission proportions. The projections indicate increases in funding for the 1st and 8th districts relative to an allocation scheme based on mission shares. The 4th and 6th districts would experience decreases, and the 9th and 12th districts would be about equal under either allocation scheme.

Table 12. FY 1992 estimated support funding and recruiting mission share

	Support budget (FY 1990 dollars)						
District	Station and recruiter	Reserve	OSO	District office	Total	Estimated budget share	FY 1992 mission share
1st	3,508,015	231,549	345,799	1,130,329	5,215,692	12.7	12.0
4th	4,994,462	329,663	425,850	1,130,329	6,880,304	16.7	17.3
6th	4,607,985	304,154	470,344	1,130,329	6,512,812	15.9	16.7
8th	5,945,788	392,457	537,579	1,130,329	8,006,153	19.5	18.8
9th	5,143,106	339,475	490,299	1,130,329	7,103,209	17.3	17.3
12th	5,529,582	364,985	342,563	1,130,329	7,367,459	17.9	17.9
Total	29,728,938	1,962,283	2,612,434	6,781,974	41,085,629	100.0	100.0

PREDICTED SUPPORT FUNDING SAVINGS FROM RS CONSOLIDATIONS

In light of the significant geographical shifts in recruiting mission, with the imposition of the PQMA approach to mission allocation, and the anticipated reductions in recruiting mission during the 1990s, it may be time to consider shifting Marine Corps recruiting boundaries and reducing overhead. This section presents an analysis of potential support funding savings from some of the proposed recruiting station consolidations.

To improve recruiting efficiency, the Marine Corps recruiting service is considering several proposals that would consolidate stations and one proposal that would consolidate a couple of districts. These proposals would move toward equalizing PQMA within districts and stations while giving some consideration to expected future shifts in the population of high school seniors.

The effect of district boundary changes will not be considered in this discussion. Furthermore, the analysis here will focus on just the support funding savings from station consolidations. When considering these consolidations, total cost savings must be the primary focus.

Any support funding savings may be offset by added costs from reduced oversight of recruiters. Consolidation could ultimately result in lower quality recruits as station-level support and supervision of recruiters is reduced. Recruiters could also experience increased workloads and, ultimately, a lower quality of life. Finally, to offset these adverse effects, more military billets may be required at the newly consolidated stations than had previously been assigned to the two separate stations.

The model estimates will be used to come up with estimates of potential support funding savings from station consolidations. To calculate support funding requirements before and after the consolidation, it is assumed that the stations are producing net contracts based on the following equation:

$$NC_i = (PQMA_i/PQMA) * 36{,}920 \quad ,$$

where

NC_i = number of net contracts procured in station i

$PQMA_i$ = production-weighted qualified military available estimates for station i

PQMA = production-weighted qualified military available estimates for the nation.

In other words, it is assumed that districts and stations have recruiting missions equivalent to their proportion of PQMA or that the Marine Corps recruiting service has completed its transition to PQMA. The national net contract number of 36,920 is used because it is the present estimate for FY 1992, and significant declines in net contract totals are unlikely over the couple of years following FY 1992.

Another assumption is that the number of substations following consolidation will simply be the sum of substations in the two stations. In other words, no substations will be closed. Also, the square mileage per PQMA is based on the FY 1992 estimates. For consolidated stations, the two stations' square mileage and PQMA are combined and a new square mileage per PQMA is calculated. Finally, estimates are made in FY 1990 dollars and, because of inflation, true support funding savings may be greater.

Six-District Proposal

The first proposal considered has been widely briefed. It includes two station consolidations, which are in the 1st and 4th districts, where it is believed the potential recruiting market will shrink over the next few years. The stations involved have recruiting missions that are smaller than the national average. The new district boundaries in this proposal are moved so that recruiting missions can be roughly equalized. The potential savings from district boundary changes will not be considered.

Table 13 shows the six-district plan's proposed consolidations and the model estimate of support funding savings. The first proposed consolidation involves RS Boston and RS Northern New England, which are both in the present 1st district. Table 7 shows that each of these stations has just over 1.5 percent of the national PQMA, or approximately 0.5 percentage points less than the national average PQMA of 2 percent for 50 stations. A consolidated station would be larger than the national average proportion of national mission but would still be smaller than the largest station, RS Macon. Based on the production levels discussed earlier, model estimates show that support funding requirements would be reduced from approximately $926,500 to $816,500, or about $110,000.

The second proposed consolidation involves Northern New Jersey in the 1st district and Philadelphia in the 4th district. Each station is currently at or below 1.5 percent of PQMA. Based on model estimates, consolidation would reduce support funding requirements by about $116,000. Thus, the model shows that support funding savings from the two consolidations totals $226,000 in FY 1990 dollars.

Table 13. Six-district reorganization plan: RS consolidation support funding savings predicted by model (in FY 1990 dollars)

RS consolidation	Estimated cost		Total saving
	Before consolidation	After consolidation	
Boston-N. New England	926,500	816,500	110,000
N. New Jersey-Philadelphia	820,000	703,500	116,500
			226,500

Four-District Proposal

A more substantial reduction in recruiting overhead has been proposed that would consolidate 2 districts and 8 stations, eventually leaving the Marine Corps with 4 districts and 42 stations. Potential support funding savings from the district consolidations will not be estimated here. Instead, the analysis will focus on the 8 station consolidations.

Table 14 provides model estimates of support funding savings from station consolidations. Note that three of the proposals involve splitting stations and allocating the parts to two other stations.[1]

The consolidations would reduce the number of stations in the 1st and 4th district boundaries from 16 to 11. No consolidations would occur in the 6th district, but there would be net reductions of one station each for the present 8th, 9th, and 12th districts. The proposals are intended to generate more mission equality between stations. Projected population trends over the next ten years were considered in formulating these consolidation proposals.

1. The basis for these splits was to have station boundaries conform with military entrance processing station (MEPS) boundaries, where possible. Additional savings may be possible by conforming with MEPS boundaries because, when two stations send recruits to a MEPS facility, each station must have a MEPS liaison, usually a noncommissioned officer. By consolidating so that a MEPS facility is only in one station, one fewer liaison is necessary at the facility.

Table 14. Four-district reorganization plans: RS consolidation support funding savings predicted by model (in FY 1990 dollars)

RS consolidation	Estimated cost		Total saving
	Before consolidation	After consolidation	
Boston-N. New England	926,500	816,500	110,000
Buffalo-Albany	853,000	734,500	118,500
New York-Hartford	891,000	804,000	87,000
N. New Jersey-Philadelphia	820,000	703,500	116,500
Pittsburgh-Charleston (Pittsburgh MEPS) and Richmond-Charleston (Beckley MEPS)	1,472,000	1,350,000	122,000
Oklahoma City-Little Rock (L.R. MEPS) and Kansas City-Little Rock (Kansas City MEPS)	1,599,500	1,515,500	84,000
Chicago-Rock Island (Chicago MEPS) and Omaha-Rock Island (Des Moines MEPS)	1,543,500	1,502,500	41,000
Orange-San Deigo	797,000	739,000	58,000
			737,000

The support funding savings range from $122,000 for the splitup of RS Charleston (with a portion going to RS Richmond and a portion to RS Pittsburgh) to $41,000 for the breakup of RS Rock Island into RS Omaha and RS Chicago. The estimated total station-level savings is $737,000, or approximately $92,000 per station. This savings is substantial but must be considered in conjunction with other cost changes.

SHORTCOMINGS OF ESTIMATES AND PROJECTIONS

Before ending this discussion, it is necessary to highlight several potential problems with the analysis in this research memorandum. First, a limited number

of variables were used to explain variations in station costs. Although these variables seem to do a reasonable job of explaining variations in the allocation of support funds to the stations, other variables that were not included may also be important.

The model does not consider any past uneven investment in stations and implicitly in districts. It assumes that each station and district starts out with equal stocks of capital.[1] There is also no consideration of added short-term costs from RS consolidations or openings. During the period included in the data, preparations were being made to open two new recruiting stations, RS Fort Lauderdale and RS Salt Lake City.

Also, during the period included in the data, significant changes occurred in Marine Corps recruiting policies that may differentially affect recruiting costs across the country. Substantial growth in the delayed entry program (DEP) meant that all recruiters were required to allocate much larger amounts of time to those participating in the DEP. It is not clear whether the added importance of the DEP increased costs differentially across the nation.

Finally, it would be a mistake to view this model as identifying the proper support funding level nationally. All that the model purports to do is to take a given level of national support funding and provide all districts with an equal opportunity, given their cost requirements.

CONCLUSION

This research memorandum presents a method for determining district support funding requirements by modeling the way districts allocated funds to stations. The model assumes that districts have accurate information about the cost of recruiting at the station and recruiter levels. Thus, they differentially distribute support funds to stations.

Several variables explained much of the variation in station funding levels. These include the number of net contracts, the station square mileage relative to the estimated station PQMA, and the number of substations in the station. The station

1. Capital might be defined as equipment used by stations and districts, but it could also include the level of recruiting know-how of civilian and military recruiting personnel. The expectation is that stations and districts with reduced amounts of capital will have higher support funding requirements.

costs per net contract, or average costs, were found to decrease with an increase in the number of net contracts that a station procures. However, average costs will increase with more substations and larger square mileage relative to the estimated PQMA.

When costs predicted by the model were aggregated up to the district level, it was found that some adjustments may be required to the present system of allocating funds on the basis of recruiting mission levels, which implicitly assumes equal average costs. Specifically, the 1st and 8th districts were found to have higher than average costs, whereas the 4th and 6th districts have lower than average costs; therefore, these districts' funding levels ought to be adjusted accordingly. The 9th and 12th districts' costs are about average.

Finally, predictions, using model estimates, were made of the potential support funding savings from several proposed station consolidations. Potential savings averaged $100,000 per station consolidation.

REFERENCE

[1] CNA Research Memorandum 89-280, *Evaluation of the USMC QMA-Based Recruiting Goaling System and a Proposed Alternative*, by Gary Horne, Jacquelyn Hughes, and William Sims, Apr 1990

APPENDIX A

MODEL SPECIFICATIONS

APPENDIX A

MODEL SPECIFICATIONS

In deriving a regression model for station support funding, two problems must be addressed before estimation can be made. First, more than one year's data are pooled in analyzing the determinants of station support funding. If parameters a and B (described in the main text), are constant across time, the accuracy of these parameter estimates would be increased by pooling multiple years of data and estimating the relationship.[1]

Shifts in the intercept parameter, a, are likely to result from changes in overall recruiting conditions between fiscal years. This variation makes the derivation of a single relationship inappropriate because it results in an estimation of a spurious relationship similar to that shown in figure A-1. Under these conditions, it is more appropriate to estimate the following relationship:

$$C_{it} = \sum_{t=1}^{T} a_t d_{it} + \sum_{j=1}^{M} B_j X_{it} + u_{it} \quad ,$$

where a dummy variable d identifies the fiscal year of the observation.[2] This method allows the estimation of different intercept parameters for each year in figure A-1.

A related problem could be caused by district effects. Bias could be introduced by not controlling for districts in the regression. As an example, if it is found that rural stations face higher costs, it must mean that more rural districts face higher costs and are subsequently underfunded relative to nonrural districts. This problem was tested by making estimates controlling for districts, and the results were identical to those without controls. Because several degrees of freedom are lost with the controls, it was decided not to include them in the estimation.

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1. Variance of parameter estimates can be reduced by increasing the sample size.
2. This is known as a fixed-effects specification of a pooled time series and cross-sectional data set where there are assumed to be fixed effects that vary with the cross sections.

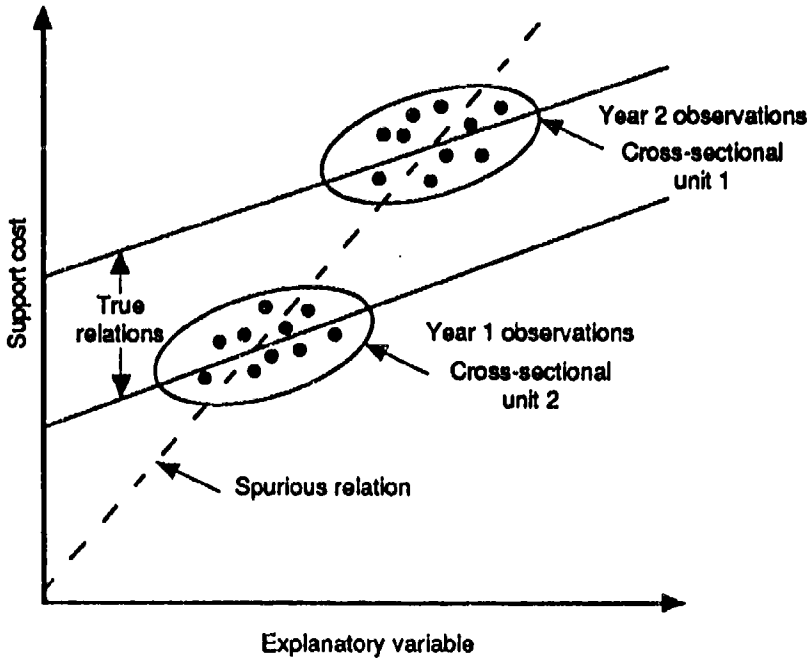

Figure A-1. Two cross sections with different intercept parameters

Another problem is specifying a functional form for the support funding equation. After attempting to estimate the relationship with several specifications, the specification that seemed to fit the data best was a log-log model. Implicit in the log-log model is the assumption that the relationship between station support funding levels and the explanatory variables is the following nonlinear relationship:

$$C = aX^B.$$

From this,

$$dC/dX = BaX^{B-1} ,$$

so, if B is positive, the slope is always positive. If $B > 1$, the slope always increases as X increases, and, if $0 < B < 1$, the slope continually decreases but remains positive as X increases. These relationships are shown in figure A-2; the shapes for $B < 0$ are shown in figure A-3.

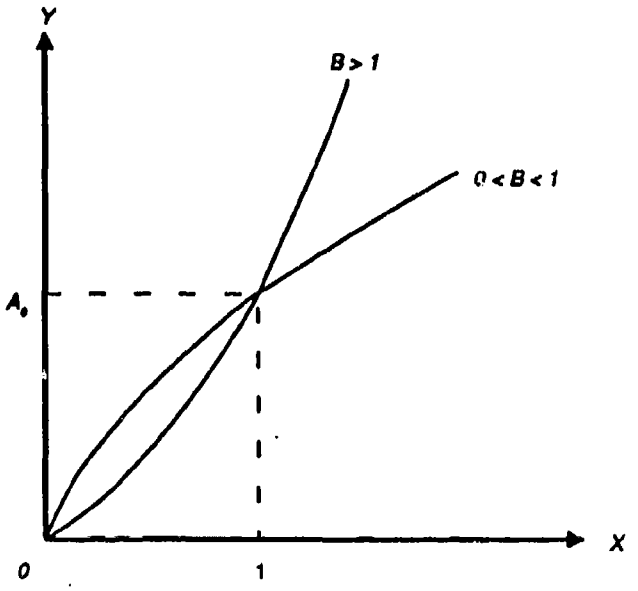

Figure A-2. The log-log model

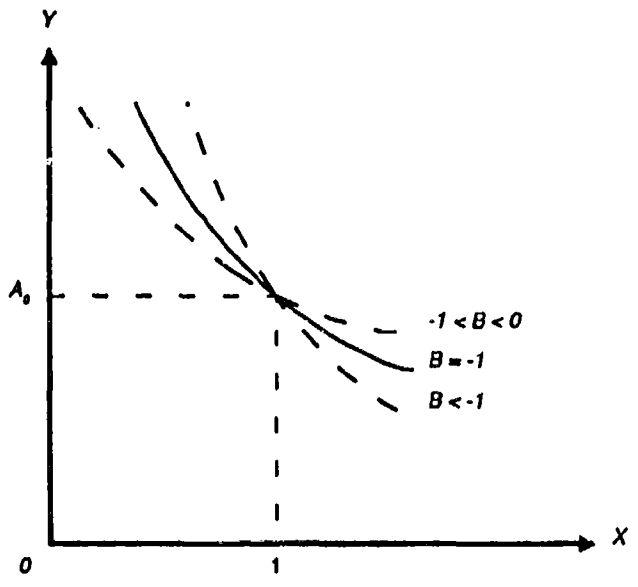

Figure A-3. The log-log model when B is less than zero

The nonlinear relationship shown above can be easily estimated by transforming both sides of the equation to natural logarithmic form:

$$\ln C = \ln a + B \ln X.$$

Parameter B is a partial elasticity with respect to X or

$$B = (d\ln C/d\ln X) = (dC/dX)(X/C).$$

In other words, B gives an estimate of a percentage change in C corresponding to a 1-percent change in X.

The proof of this relationship is as follows;

$$(d\ln C/d\ln X) = (d\ln C/dC)(dC/dX)(dX/d\ln X) = (1/C)(dC/dX)(X/1)$$

or

$$d\ln C/d\ln X = (X/C)(dC/dX).$$

Thus, changes in X will yield a constant percentage change in C. See [A-1] for further details.

REFERENCE

[A-1] J. Johnston. *Econometric Methods*. 3rd ed. New York: McGraw-Hill Book Co., 1984

APPENDIX B

REGRESSION ESTIMATES

APPENDIX B

REGRESSION ESTIMATES

Table B-1 shows the results of the estimation. The first number is the parameter estimate. As discussed in appendix A, these parameter estimates are partial elasticities, except the parameter estimate for FY 1990, which was not specified in logarithmic form.

The terms in parentheses are the t statistics, which provide inference about the statistical significance of the parameter estimate. In all cases, the parameters are significant for a two-tailed test at the 10-percent level of significance. Only the number of substations is not significant at the 5-percent level of significance. All other parameters are significant at the 1-percent level of significance. In other words, given the model specification, there is a 90-percent chance that number of substations has a nonzero underlying relationship with station support costs and a 99-percent chance that net contracts and square miles per PQMA have a nonzero underlying relationship with station support costs.

The R^2 term indicates the explanatory power of the regression. It indicates that 74 percent of the variation in station support funding is explained by variation in the three explanatory variables.

Table B-1. Ordinary least squares estimates using FY 1989 and FY 1990 data

Variable	Coefficient (t statistic)
Constant	8.242 (25.05)
Log of substations	0.093 (1.88)
Log of net contracts	0.686 (13.35)
Log of square miles per PQMA (times 100)	0.059 (5.19)
Year is 1990	–0.121 (–4.60)
Number of observations	96
Adjusted R^2	0.74

NOTE: Dependent variable: log of station support costs.

APPENDIX C

STANDARD DEVIATION

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STANDARD DEVIATION

As indicated by table 8 in the main text, the distribution of the explanatory variables varies widely. In analyzing the effect of a change in these explanatory variables on support funding, it is necessary to account for the variation in these variables to provide an indication of how changes in explanatory variables affect support funding. A change of 10 percent in the value of each explanatory variable might give a fair comparison for the number of net contracts and the number of substations, but it would be a relatively small change for square miles per PQMA.

To provide a better yardstick of typical changes that might occur in the explanatory variable, the effect of an increase of one standard deviation in the explanatory variable over the sample mean is used. The following equation measures the standard deviation of a population:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N} (X_i - U)^2}{N}} \quad ,$$

where X_i is the ith measurement in the population. The difference between this measurement and the population mean U is $(X_i - U)$. This term is squared to get the squared deviation, and these values are summed over all N measurements in the population. To get the mean of these squared deviations, the summed term is divided by N. This term is known as the variance. Finally, the standard deviation is arrived at by taking the square root of the term. A larger value indicates that the data are more dispersed.

The above equation is used when all values are known for the entire population. If the total collection of observations is known, this measure will suffice. However, if only a sample of the total collection is taken, as is the case in this study with only two years of data, another equation is needed:

$$S = \sqrt{\frac{\sum_{i-1}^{n} (X_i - \bar{X})^2}{n - 1}} \quad .$$

There are two changes. The sample mean $\bar{X}$ is employed and the sum of the squared deviation from the mean is divided by $(n - 1)$.

A verbal description of the above is that a sample's standard deviation gives the typical distance between a sample observation and the mean value. If an observation were randomly selected, it would, on average, be one standard deviation in distance from the sample mean.

From table 8, the standard deviation for square miles per PQMA is about 140 percent of the size of the mean value for square miles per PQMA. The standard deviations for the number of net contracts and number of substations are about 30 percent of their mean value.